IN THE SPECIFICATION

Paragraphs [0001] – [0205] are in this application.

Paragraphs [0021], [0024], [0026], [0027], [0029], [0030], [0062], [0066], [0079], [0086], [0087], [0101], [0102], [0106], [0112], [0114], [0131], [0132], [0133], [0134], [0137], [0138], [0139], [0146], [0153], [0166], [0189] and [0195] are Currently amended.

All other paragraphs are Original, as originally filed, but are not reproduced in this Amendment.

Change the title of the application to ~~Liquid~~ Cooling System

[0021] (Currently amended) In one embodiment, the ~~liquid~~ cooling system as set forth above, wherein the ~~liquid~~ cooling system is disposed in a casing, the ~~liquid~~ cooling system further comprising a heat exchange system including a heat dissipater in fluid ~~liquid~~ communication with the outlet; a ~~liquid~~ cavity in liquid communication with the heat dissipater for receiving ~~storing~~ cooled ~~liquid~~ coolant; and a pump disposed within the ~~liquid~~ cavity for circulating the liquid ~~liquid~~ coolant through the ~~liquid~~ cooling system.

[0024] (Currently amended) A ~~liquid~~ cooling system comprises a first conduit transporting first liquid; a first heat transfer unit coupled to the first conduit and capable of mating with a processor on a first side, the processor generating heat, the first heat transfer unit capable of ~~dissipating~~ removing ~~the~~ heat by conveying the first liquid through the first heat transfer unit; a second heat transfer unit coupled to the first conduit and capable of mating with the processor on a second side, the second heat transfer unit capable of further ~~dissipating~~ removing ~~the~~ heat by conveying the first liquid through the second heat transfer unit; and a second conduit coupled to the first heat transfer unit and coupled to the second heat transfer unit, the second conduit

transporting second liquid in response to conveying the first liquid through the first heat transfer unit and in response to conveying first liquid through the second heat transfer unit.

[0026] (Currently amended) A ~~liquid~~ cooling system comprises a first conduit transporting first liquid; a first heat transfer system coupled to the first conduit and capable of mating with a first processor on a first side, the first processor generating first heat, the first heat transfer unit capable of ~~dissipating~~ removing ~~the~~ first heat by conveying the first liquid through the first heat transfer system; a second heat transfer system coupled to the first conduit and capable of mating with the first processor on a second side and a second processor on a first side, the second heat transfer system capable of further ~~dissipating~~ removing ~~the~~ first heat by conveying the first liquid through the second heat transfer system and the second heat transfer system capable of ~~dissipating~~ removing ~~the~~ second heat by conveying the first liquid through the second heat transfer system; a third heat transfer system coupled to the first conduit and capable of mating with the second processor on a second side, the third heat transfer system capable of further removing ~~dissipating the~~ second heat by conveying the first liquid through the third heat transfer system; and a second conduit coupled to the first heat transfer system, coupled to the second heat transfer system and coupled to the third heat transfer system, the second conduit transporting second liquid in response to conveying the first liquid through the first heat transfer system, in response to conveying first liquid through the second heat transfer system and in response to conveying first liquid through the third heat transfer system.

[0027] (Currently amended) A ~~liquid~~ cooling system comprises a first housing comprising a first receptacle capable of mating with first packaging material associated with a first processor, to form a first cavity, the first processor generating first heat; a second housing comprising a second receptacle capable of mating with second packaging material associated with the first processor and comprising a third receptacle capable of mating with third packaging material associated with a second processor, to form a second cavity, the second processor generating second heat; a third housing comprising a fourth receptacle capable of mating with fourth packaging material associated with the second processor, to form a third cavity; a first inlet

disposed in the first housing, the first inlet receiving first liquid, the first liquid flowing through the first cavity and ~~dissipating~~ removing ~~the~~ first heat by making contact with the first packaging material; a second inlet disposed in the second housing, the second inlet receiving second liquid, the second liquid flowing through the second cavity and ~~dissipating~~ removing ~~the~~ first heat by making contact with the second packaging material, the second liquid flowing through the second cavity and ~~dissipating~~ removing ~~the~~ second heat by making contact with the second packaging material; a third inlet disposed in the third housing, the third inlet receiving third liquid, the third liquid flowing through the third cavity and removing ~~the~~ second heat by making contact with the fourth packaging material; a first outlet disposed in the first housing, the first outlet providing and exit point for the first liquid flowing through the first cavity; a second outlet disposed in the second housing, the second outlet providing and exit point for the second liquid flowing through the second cavity; and a third outlet disposed in the third housing, the third outlet providing and exit point for the third liquid flowing through the third cavity.

[0029] (Currently amended) A ~~liquid~~ cooling system comprises a circuit board capable of receiving a processor generating heat; a heat conducting material deployed within the circuit board and receiving the heat from the processor; and a conduit coupled to the heat conducting material, the conduit ~~dissipating~~ removing heat in the heat conducting material by transporting ~~liquid~~ coolant through the conduit.

[0030] (Currently amended) A liquid cooling system comprises a circuit board capable of receiving a processor generating heat; a heat conducting material deployed within the circuit board and receiving ~~the~~ heat from the processor, the heat conducting material forming a cavity, the cavity providing a conduit for ~~liquid~~ coolant to flow through the cavity, the ~~liquid~~ coolant ~~dissipating~~ removing ~~the~~ heat; an conduit coupled to the cavity, the conduit providing and entry point for the ~~liquid~~ coolant; and an conduit coupled to the cavity, the conduit providing and exit point for the ~~liquid~~ coolant.

[0062] (Currently amended) In one embodiment of the present invention, a two-piece ~~liquid~~ cooling system having no reservoir is presented. The two-piece ~~liquid~~ cooling system includes: (1) a heat transfer system, which is capable of attachment to a processor, and (2) a heat exchange system. In one embodiment, a single conduit is used to couple the heat transfer system to the heat exchange system. In a second embodiment, a conduit transporting heated ~~liquid~~ and a conduit transporting cooled ~~liquid~~ are used to couple the heat transfer system to the heat exchange system. It should also be appreciated that the two-piece liquid cooling system may also be deployed as a one-piece liquid cooling system by deploying the heat transfer system and the heat exchange system in a single unit (i.e., a single consolidated embodiment).

[0066] (Currently amended) Fig. 1 displays a system view of a ~~liquid~~ cooling system disposed in a housing and implemented in accordance with the teachings of the present invention. A housing or case 100 is shown. In one embodiment, the housing or case 100 may be a computer case, such as a standalone computer case, a laptop computer case, etc. In another embodiment, the housing or case 100 may include the case for a communication device, such as a cellular telephone case, etc. It should be appreciated that the housing or case 100 will include any case or containment unit, which houses a processor or other heat generating components.

[0079] (Currently amended) During operation, cooled liquid as depicted by direction arrows 128 is transported in the conduit 118A/118B to the heat transfer system 106. The cooled ~~liquid~~ coolant 128 in the conduit 118A/118B moves through a cavity in the heat transfer system 106 as shown by liquid direction arrow 122. In one embodiment, the heat transfer system 106 transfers and removes heat from the processor 104 to the liquid denoted by direction arrow 122. Heating the liquid in the heat transfer system 106 with the heat from the processor 104 transforms the cooled liquid 128 to heated liquid. It should be appreciated that the terms cooled liquid and heated liquid are relative terms as used in this application and represent a liquid that has been cooled and a liquid that has been heated, respectively. The heated liquid is then transported on conduits 108A/108B as depicted by directional arrows 124. In one embodiment of the present invention, the cooled liquid 128 enters the heat transfer system 106 at a lower point than the exit

point for the heated liquid depicted by directional arrows 124. As a result, as the cooled liquid 128 is heated it becomes lighter and rises in the heat transfer system 106. This creates liquid movement, liquid momentum, and liquid circulation (i.e., convective liquid circulation) in the liquid cooling system.

[0086] (Currently amended) Fig. 2 displays a sectional view of a heat exchange system implemented in accordance with the teachings of the present invention. Fig. 2 displays a sectional view of heat exchange system 112 having no reservoir along section line 140 shown in Fig. 1. A cross section of the motor 114 is shown. The motor 114 is positioned above heat exchange system 112; however, the motor 114 may be positioned on the sides or on the bottom of heat exchange system 112. Further, heat exchange system 112 may be deployed without the motor 114 and derive power from another location in the system.

[0087] (Currently amended) Heat exchange system 112 includes an input cavity 200, a heat dissipater 210, and an output cavity 212. In one embodiment, the motor 114 is connected through a shaft 202 to an impeller 216, disposed in an impeller case 214. In one embodiment, the input cavity 200 is connected to the conduit 108B. In another embodiment, an impeller case 214, an impeller casing input 220, and an impeller exhaust 218 are positioned within the output cavity 212. The impeller exhaust 218 is connected to the conduit 118B. Further, in one embodiment, liquid tubes 208 run through the length of the heat dissipater 210 and transport liquid from the input cavity 200 to the output cavity 212. In yet another embodiment, heat exchange system 112 may be fitted with a snap-in unit for easy connection as a single unit within or to housing or case 100 of Fig. 1. In all of the above embodiments, there is no reservoir employed or used in the cooling system.

[0101] (Previously presented) Coolant ~~cavity~~ reservoir 314 receives and stores cooled liquid 320 from conduit 328. Cooled liquid 320 is a non-corrosive, low-toxicity liquid, resilient and resistant to chemical breakdown after repeated usage while providing efficient heat transfer and protection against corrosion. Depending upon particular cost and design criteria, a number of

gases and liquids may be utilized in accordance with the present invention (e.g., propylene glycol). Coolant ~~cavity~~ reservoir 314 is a sealed structure appropriately adapted to house conduits 328 and 308. Coolant ~~cavity~~ reservoir 314 is also adapted to house a pump assembly 316. Pump assembly 316 may comprise a pump motor 312 disposed upon an upper surface of coolant ~~cavity~~ reservoir 314 and an impeller assembly 324 which extends from the pump motor 312 to the bottom portion of coolant ~~cavity~~ reservoir 314 and into cooled liquid 320 stored therein. The portion of delivery conduit 308 within coolant ~~cavity~~ reservoir 314 and pump assembly 316 are adapted to pump cooled liquid 320 from coolant 314 ~~cavity~~ reservoir into and along conduit 308. In one embodiment, pump assembly 316 includes a motor 312, a shaft 322 and an impeller 324. Conduit 308 may be directly coupled to pump assembly 316 to satisfy this relationship or conduit 308 may be disposed proximal to impeller assembly 324 such that the desired pumping is effected.

[0109] (Currently amended) In an embodiment, ~~liquid~~ cooling system 300 represents an application of the present invention in larger data processing systems, such as personal computers or server equipment. Heat exchange system 310 comprises a coolant ~~cavity~~ reservoir 314 and a heat exchange system 330 coupled together by liquid conduit 328. Liquid cooling system 300 further comprises conduit 308, which couples coolant ~~cavity~~ reservoir 314 to transfer system 304. Liquid cooling system 300 further comprises conduit 306, which couples heat exchange system 310 to the heat transfer system 304. Conduit 308 transports cooled liquid 320 from coolant ~~cavity~~ reservoir 314 to the heat transfer system 304. Liquid conduit 306 receives and transfers heated liquid from the heat transfer system 304 to heat exchange system 310. Conduit 328 transports cooled liquid from heat exchange system 330 back to coolant ~~cavity~~ reservoir 314. Conduits 306, 308, and 328 may comprise a number of suitable rigid, semi-rigid, or flexible materials (e.g., copper tubing, metallic flex tubing, or plastic tubing) depending upon desired cost and performance characteristics. Conduits 306, 308, and 328 may be inter-coupled or joined with other system components using any appropriate permanent or temporary contrivances (e.g., such as soldering, adhesives, or mechanical clamps).

[0102] (Currently amended) Coolant ~~cavity~~ reservoir 314 receives and stores cooled liquid 320 from conduit 328. Cooled liquid 320 is a non-corrosive, low-toxicity liquid, resilient and resistant to chemical breakdown after repeated usage while providing efficient heat transfer and protection against corrosion. Depending upon particular cost and design criteria, a number of gases and liquids may be utilized in accordance with the present invention (e.g., propylene glycol). Coolant ~~cavity~~ reservoir 314 is a sealed structure appropriately adapted to house conduits 328 and 308. Coolant ~~cavity~~ reservoir 314 is also adapted to house a pump assembly 316. Pump assembly 316 may comprise a pump motor 312 disposed upon an upper surface of coolant ~~cavity~~ reservoir 314 and an impeller assembly 324 which extends from the pump motor 312 to the bottom portion of coolant ~~cavity~~ reservoir 314 and into cooled liquid 320 stored therein. The portion of delivery conduit 308 within coolant ~~cavity~~ reservoir 314 and pump assembly 316 are adapted to pump cooled liquid 320 from coolant 314 ~~cavity~~ reservoir into and along conduit 308. In one embodiment, pump assembly 316 includes a motor 312, a shaft 322 and an impeller 324. Conduit 308 may be directly coupled to pump assembly 316 to satisfy this relationship or conduit 308 may be disposed proximal to impeller assembly 324 such that the desired pumping is effected.

[0106] (Currently amended) Heat transfer system 420 includes a cavity (not shown in Fig. 4A). Heat transfer system 420 receives ~~and stores~~ cooled liquid from conduit 418. The cooled liquid is a non-corrosive, low-toxicity liquid, resilient and resistant to chemical breakdown after repeated usage while providing efficient heat transfer. Depending upon particular cost and design criteria, a number of gases and liquids may be utilized in accordance with the present invention (e.g., propylene glycol).

[0112] (Currently amended) A motor 512 is also positioned in the heat exchange system 504. The motor 512 and the cavity 514 form a sealed cavity for ~~seal that retains~~ liquid 518 ~~in the cavity 514.~~ The motor 512 is connected to an impeller 516, which is deployed in the cavity 514. In one embodiment, the motor 512 in combination with the impeller 516 is considered a pump.

In another embodiment, the impeller 516 is considered a pump. Conduit 510 brings cooled liquid into the cavity 514 and conduit 520 removes the cooled liquid ~~air~~ from the cavity 514.

[0114] (Currently amended) Cavity 514, which acts as a reservoir, receives and stores cooled liquid. Liquid 518 is a non-corrosive, low-toxicity liquid, resilient and resistant to chemical breakdown after repeated usage while providing efficient heat transfer and corrosion prevention. Depending upon particular cost and design criteria, a number of gases and liquids may be utilized in accordance with the present invention (e.g., propylene glycol). Cavity 514 is a sealed structure appropriately adapted to house conduits 510 and 520.

[0131] (Currently amended) Fig. 8A displays a sectional view of an embodiment of a direct-exposure heat transfer system implemented in accordance with the teachings of the present invention. Fig. 8A displays a heat transfer system 800 suitable for use as the heat transfer system 402 of Fig. 4. In addition, heat transfer system 800 may also be deployed in the liquid cooling systems shown in Figs. 1 through 5. Packaging material 816 is coupled with housing 802 to form cavity 804. The cavity 804 is a sealed cavity that houses liquid 814. The liquid 814 enters the cavity 804 through conduit 810 and exits the cavity 804 ~~814~~ through conduit 808. A motor 806 and an impeller 812 are deployed in the cavity 804. In another embodiment, the motor 806 may be deployed outside of the cavity 804. The packaging material 816 is coupled with a processor 818 that generates heat.

[0132] (Currently amended) During operation, processor 818 generates heat. The heat is transmitted through packaging material 816. Cooled liquid flows from a heat exchange system, such as a heat exchange system shown in Figs. 1 through 5 (not shown in Fig. 8A), into the cavity 804 through conduit 810. The cooled liquid directly engages the packaging material 816 and the heat is transferred from the packaging material 816 to the cooled liquid that entered the cavity 804. As the heat is transferred to the cooled liquid, the cooled liquid becomes heated liquid. The heated liquid is then sucked into the impeller 812 and then ~~output~~ transported from the cavity 804 through the conduit 808.

[0133] (Currently amended) The liquid 814 directly makes contact with the packaging material 816. As such, the heat is transferred from the processor 818 to the packaging material 816 and then finally to the liquid 814. The transfer of the heat from the processor 818 to the packaging material 816 and then finally to the liquid 814 has the effect of removing ~~dissipating~~ ~~the~~ heat generated by the processor 818.

[0134] (Currently amended) In one embodiment, the conduit 810 is positioned below the conduit 808. As such, when the heavier-cooled liquid enters the cavity 804 and is heated, the heavier-cooled liquid becomes lighter-heated liquid. The lighter-heated liquid rises in the cavity 804. Rising in the cavity 804 facilitates the exit of the lighter-heated liquid. For example, in one embodiment, the impeller 812 may be positioned toward the top of the cavity 804 to receive the lighter-heated liquid as it rises to the top of the cavity 804. The lighter-heated liquid is then sucked into the impeller 812 and ~~output~~ transported through the conduit 808.

[0137] (Currently amended) During manufacturing, the packaging material 816 may be coupled to the housing 802 using a variety of procedures. The packaging material 816 is mated with the housing 802 to form a sealed cavity capable of storing liquid 814. During operation, processor 818 generates heat. The heat is transmitted through packaging material 816. Cooled liquid flows from a heat exchange system (not shown in Fig. 8A) into the cavity 804 through conduit 810. The cooled liquid directly engages the packaging material 816 and the heat is transferred from the packaging material 816 to the cooled liquid that entered the cavity 804. As the heat is transferred to the cooled liquid, the cooled liquid becomes heated liquid. The heated liquid is then sucked into the impeller 812 and then ~~output~~ transported from the cavity 804 through the conduit 808.

[0138] (Currently amended) The liquid 814 makes direct contact with the packaging material 816. As such, the heat is transferred from the processor 818 to the packaging material 816 and then finally to the liquid 814. The transfer of the heat from the processor 818 to the packaging

material 816 and then finally to the liquid 814 has the effect of cooling the processor 818 or ~~dissipating~~ removing heat from the processor 818.

[0139] (Currently amended) In one embodiment, the conduit 810 is positioned below the conduit 808. As such, when the heavier-cooled liquid enters the cavity 804 and is heated, the heavier-cooled liquid becomes lighter-heated liquid. The lighter-heated liquid rises in the cavity 804 and facilitates the exit of the lighter-heated liquid. For example, in one embodiment, the impeller 812 may be positioned toward the top of the cavity 804 to receive the lighter-heated liquid as it rises to the top of the cavity 804. The lighter-heated liquid is then sucked into the impeller 812 and ~~output~~ transported through the conduit 808.

[0146] (Currently amended) During operation, processor 902 produces heat, which is transferred through first packaging material 904 and second packaging material 908. As liquid flows through the cavity 922 and the cavity 907, the heat from the processor 902 is removed ~~dissipated~~.

[0153] (Currently amended) During one embodiment of the present invention, heat is generated by processor 1002 and is transferred through first packaging material 1004 and second packaging material 1008. As such, the liquid flowing through cavities 1022 and 1007 impact the packaging material 1004 and 1008, respectively. As a result, liquid impacts two sides of the processor 1002. As a result, heat is ~~dissipated~~ removed from both sides of the processor 1002.

[0166] (Currently amended) During operation, processor 1116 produces heat, which is transferred through packaging material 1114 and packaging material 1118. As heat flows through the packaging material 1114 and the packaging material 1118 to liquid flowing through cavities 1132 and 1112, the heat from the processor 1116 is ~~dissipated~~ removed. Processor 1108 also produces heat, which is transferred through packaging material 1110 and 1106. As heat flows through the packaging material 1110 and 1106 to liquid flowing through cavities 1112 and 1104, ~~the~~ heat from processor 1108 is ~~dissipated~~ removed.

[0189] (Currently amended) In one embodiment, cavity 1302 has an inner wall 1303 that forms a container for liquid flowing through the heat transfer system 1300. In this configuration, the cavity 1302 is positioned around the packaging material 1304 to provide cooling for the semiconductor material 1306. Liquid then flows through the cavity 1302 and ~~is contained in the cavity 1302~~ does not leak there from. In a second embodiment, inner wall 1303 is removed and the liquid circulating in the cavity 1302 is in direct contact with the packaging material 1304. In both embodiments, cooled liquid enters the cavity 1302 through conduits 1308 and 1313. Heated liquid then exits the cavity 1302 through conduits 1310.

[0195] (Currently amended) During operation, heat is generated by heat generating elements 1403. The heat is transported by conductive material 1410. As ~~liquid~~ coolant flows through conduits 1404 and 1406, ~~the~~ heat is ~~dissipated~~ removed. In one embodiment of the present invention, the circuit board implementation of a heat transfer system 1400 is connected to any one of the foregoing heat exchange units depicted in Figs. 1 – 5. As a result, cooled liquid is transported from the heat exchange system to the circuit board implementation of a heat transfer system 1400. The cooled liquid is transported through conduits 1404 and 1406. Heat is transported from the conductive material 1410 to the cooled liquid transported through conduits 1404 and 1406. As a result, the cooled liquid transported through conduits 1404 and 1406 becomes heated liquid. The heated liquid is then transported back to the heat exchange system for cooling.